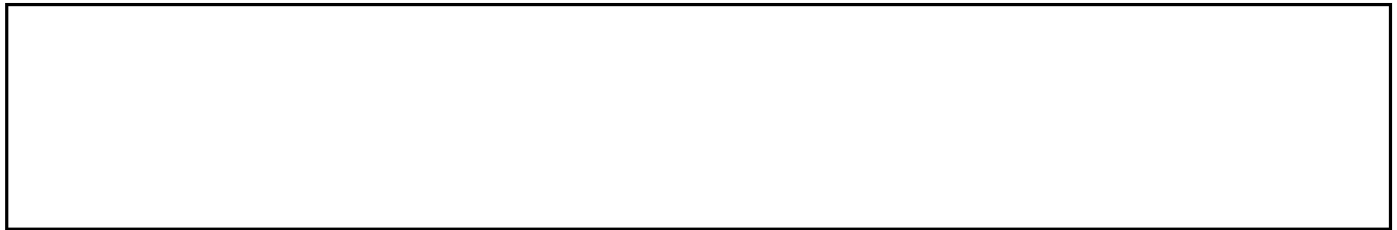


STAT



August 18, 1970

Attention: John C.

Dear John:

STAT Enclosed for your files are three (3) copies of Activity Summary, 2201201-AS-12. Attached to this Activity Summary is the Program Plan of the objectives for the next two week period.

Sincerely,

STAT



Senior Staff Scientist

PSC/c
Enclosures



August 18, 1970

ACTIVITY SUMMARY

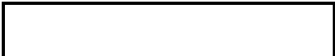
To: John C.
From: 
Subject: Contract Visit to Customer Facility
 00-6076) 70R
Date: 11, 12 August 1970
Reference: /2201021-AS-12

STAT

STAT

STAT

STAT

The activity during this visit at the 
 emphasized the specification, fabrication, test and evaluation of high frequency enhancement filters. The form selected for the filter is an inverse Gaussian amplitude transmittance filter. This selection is based on previous analysis performed earlier for objectives of noise reduction and high frequency enhancement over a large class of targets. The inverse Gaussian is being initially defined within certain boundary conditions delineated in the notebook. The validity of these initial conditions will be determined during a controlled test series. The test series was specified and is discussed in the attached Program Plan. The objectives of the next two week period are also discussed therein.

STAT

During this visit a brief review of the status of the coherent processing effort was performed. An initial series of amplitude filters were also fabricated. The visit period was 1-1/2 days. It is recommended that a three day laboratory working visit be scheduled for the week of August 24.

To John C.

From.

Subject Program Plan
Lab Effort
High Frequency Enhancement

Date. Aug 12, 1970

At this time the primary requirement is to generate the inverse Gaussian filters for high frequency image enhancement

The filters will be of the form illustrated in Fig 1.

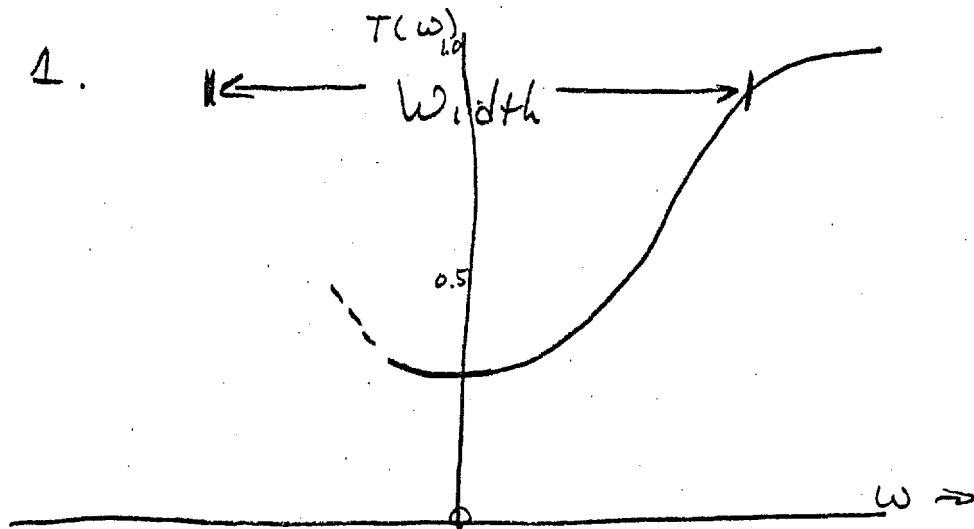


Fig 1 Example of inverse Gaussian transmittance

The purpose of the inverse Gaussian

filter is to perform a smoothing operation on the frequency spectrum of an image. Whereas the high frequency components are normally of low contrast relative to the low frequency components, this filter is intended for reorienting the distribution and increase (enhance) the high frequency components relative to the low frequency components. The following figure (Figure 2) illustrates this. The filter function product with the

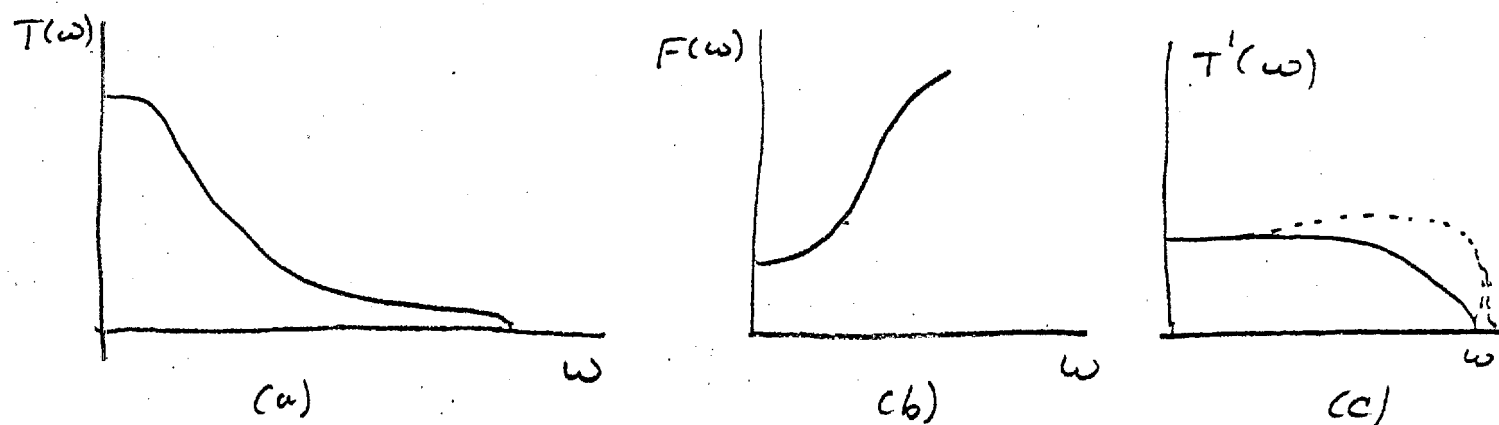


Figure 2

transfer function yields a new distribution.

The new distribution illustrated in Fig 2(c) is sketched for two possible responses. We will work towards the definition of the optimum form as this program progresses.

The present requirements are to fabricate filters, evaluate them and apply them. By this method we will specify the best filter type. To specify the inverse Gaussian filter we select the two parameters, $T(\omega)$, ~~and~~ the transmission at the center where it is minimum, and its width at the 90% transmission point. (see Fig 1), $T(\omega)_{90\%}$. Several boundary conditions can be selected for initially determining $T(\omega)$ and the width function. These are, $T(\omega) \approx 30\%$ and the width approximately $\frac{1}{3}$ the cut-off of typical

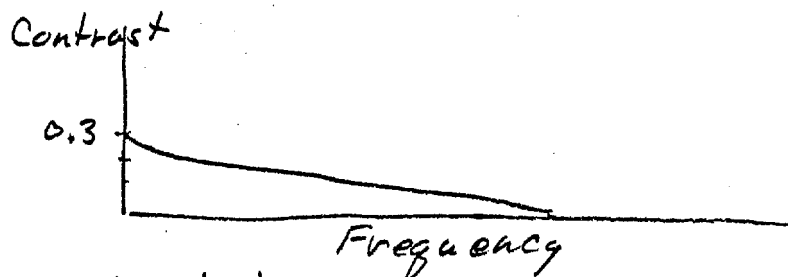
film input. The exact specifications of best filters can only be based on experimental results.

The program plan to test and evaluate filters is as follows.

Program Plan

1. Fabricate Gaussian shaped filters using a defocused image of a pinhole to obtain the functional form. Expose so that $T_{co} \approx 30\%$ and that the 90% transmission diameter is approximately $\frac{1}{3}$ the spread of the cut-off frequency of the input-processing system.

2. Fabricate a resolution target test chip for initial evaluation of the filters. The chip should be low contrast and with an envelope determined by the copy lens. Thus the filter would be of the describable form



3. Use the test target for input to the optical system. Select filters of constant diameter, varying in T_{co} , and determine best range.

4. From best T_{co} generate a resolution target diameter and determine best diameter range

for this target.

5. Categorize filters relative to target and file accordingly.

The above scope of effort can be performed during a two week period. Following this series we can input a continuous tone target and evaluate filters relative to improved appearance of the imagery. A class of low contrast images should be selected for input. We should also plan on limiting the high frequency component of the filter.

Aug 25/1976

Subject

Instructor's Name

High Pass Filtering

AM

Dennis worked on the system and stated that there was edge ringing and aberrations due to the lens.

Observations & Conclusions on Dennis's work.

1. The aberrations may be defocusing since group 2-6 looks better than group 2-5 (we will have to use a microscope to prove this but I think group 2-5 may be at a zero of the defocused transfer function)
2. The ringing is present in the photos that Dennis took on the 24th but there doesn't seem to be much there at the present time.

One reason may be the fact that we are now using a much lower contrast target (D.L.) 1.35:1 (compared to 3.5:1)

Photos

Photographs of the output will be taken to see if there is more there than the eye can see. (Ringing, etc.)

4 sets of photo will be taken

1. No filter but glass in the filter plane
2. A 4 filter
3. A 3 filter

4. A 2 filter with 50 watt filter

Subject

Instructor's Name

P.H.Observations of the photographed output

The system output showed a very dirty beam, thus we cannot say anything about the photo's taken this morning.

Back bench realignment + cleanups.

1. Starting with the Hg lamp - a new 200W* lamp was installed.
2. New optics before the pinhole (Two 32mm objectives)
3. Bore a 1004 25mm pinhole will be used.
4. All three lens were taken apart and cleaned (They were very dirty on the inside)
5. Complete system was realigned.

* The 200 watt lamp gives a very large are and therefore it is wasted where small pinholes are used (This is compared to a 100W Hg lamp)

The realignment + general cleanups of the system was complete by 5 P.M.

Subject

Instructor's

AM Test series to see if the beam is clean.

1. 100 μ pinhole
 - a without target + filter
 - b with target + no filter
2. 25 μ pinhole
 - a without target + filter
 - b. with target + no filter

Results

Beam has no improvement

New conditions

- I 1. Larger pinhole (less coherence)
2. Ground glass between two objectives after the 200w Hg lamp.

Exposure series

1. glass in film plane
500 μ pinhole
 $ND = 4$ after pinhole
 $t_{exp} = \frac{1}{250} - \frac{1}{4} sec.$

2. 500 μ pinhole
 $ND = 4$

3. 500 μ
 $ND = 2$

Ground glass in between microscope objectives

4. 25 μ

Subject

Instructor's Name

2nd roll

5. 100m

Ground glass (with glass side facing 200w Hg)
ND = ND3rd roll

6. 100m

Ground glass after pinhole
ND = 2

7. 100m

Ground glass.
ND = 0

8. 500m

Ground glass
ND = 2

9. 500m

G.G. before pinhole
ND = 1 $T_{exp} = \frac{1}{500} - 1 \text{ sec.}$ 4th roll

10. 100m

G.G. before pinhole
ND = 0

11. 25m

G.G. before pinhole
ND = 0 T_{exp} up to 15 sec.

Subject

Instructor's Name

AMSystem Exposures.

Roll #1

1. 500u
Ground Glass before pinhole

$\frac{1}{1000}, \frac{1}{500}, \frac{1}{60}, \frac{1}{15}, \frac{1}{4}, 1$

Blind Exp
at the end
of each
series

2. 500u
Ground Glass after pinhole

uneven

uneven
camera
problems
at $\frac{1}{1000}, \frac{1}{250}$

Not
photographed { 3. 100u
Ground Glass before pinhole
" " after "

In both cases the beam at the image plane was not uniform due to the ground glass.

The only way this can be prevented is to move the ground glass ~~continuously~~ while exposures are made.

4. 25u
G.G. before pinhole

$\frac{1}{15}, \frac{1}{4}, 1, 4, 16, 1 \text{ min.}$ (over exp. with white light)

Not
photographed { 5. 25u

G.G. after pinhole

{ Non uniform beam in image plane

6. GG between microscope objective
a 25u $\frac{1}{15} - 1 \text{ min}$ (flashlight)

Roll #2
No photos { b. 100u Ground glass imaged
c. 500u " " "

Subject

Instructor's Name

Results

Noise is caused by too much coherence
 $\therefore$ 25 μ pinholes should be avoided
 100 μ " " " "

New Exposure Series

Roll 2

500 μ pinhole Wratten 58 filter
 ND = 2 T_{exp} 1/1000 - 4 sec. factor of 2

500 μ pinhole Wratten 58
 ND = 2 T_{exp} 1/1000 - 4 sec. factor of 2

(a) GG before pinhole

(b) GG after pinhole

P17

System setup with a 500 μ pinhole - ground glass
 before pinhole - Beck green filter.

filter #3 $1/60$ - 1 sec / each stop

" #1 $1/60$ - 4 sec

No filter $1/25$ - 1 sec.

Results.

The standard amount of coherent noise is present
 but overall the 3 sets above looked good.

Subject

Instructor's Name

Things to try

1. Decrease the size of the pinhole from the present 500 μ until coherent noise starts to interfere with us.
2. Longer focal length coll lens.
 - a. decrease spot size
 - b. increase coherence.

Illustration of output

Subject

Image Manipulation

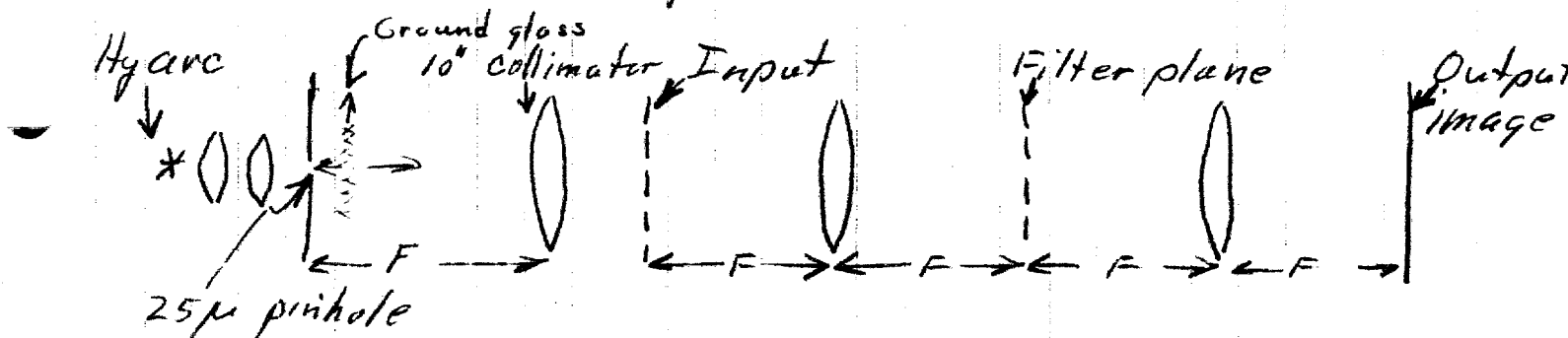
Instructor's Name

Program objective

High frequency enhancement

- Contrast enhancement
- Edge sharpening

Equipment set-up adjusted to provide more flexibility.



F=10"

This system set-up will provide additional flexibility in partially coherent image processing. As we go from a coherent to incoherent condition the frequency response for the system changes — and noise artifacts change. A trade-off is required to get the best condition for image high frequency enhancement.

Sept 17, 1970

Exposure series with

a)	no ground glass		
b)	GG at pos'n 1	GG ca. 1/4" from pinhole	
c)	" "	+6 mm	" "
d)	" "	13	" "
e)	" "	19	" "
f)	" "	24	" "
g)	" "	38	" "
h)	" "	55	" "
i)	" "	82	" "
j)	" "	111	" "

Subject

- 1) 100 μ pinhole placed in system.
- 2) Positions d-f give best resolution results

Group 2^{#5} recorded on film.
" 2^{#6} visually noted using
30x microscope viewer.

At large g.g. positions, res.
drops off.

The intensity has been increased
by a large factor in going from the
25 μ m to 100 μ m pinhole diameter.
Should be a 16x increase in
brightness.

To do

Now require to generate

- a) Filters of low density
- b) Targets, both deterministic
and non-deterministic.

Filters

2, 4, 6, 8, 10 mm diameter
0.4 to 0.7 density.

Subject

Ins

Diffraction equation

$$d = \lambda F w$$

$$F = 10" = 254 \text{ mm.}$$

d = distance of diffraction

$$\lambda = 0.54 \mu\text{m}$$

w = spatial frequency

$$\lambda F = 0.137.16 (\text{mm})^2$$

$$w = 14.6 \text{ l/mm for } d = 2 \text{ mm}$$

29.2	"	4	"
43.8	"	6	"
58.4	"	8	"
73.0	"	10	"

For low frequency objects we will require lower (smaller diameter) frequency filters.

Filters being fabricated

diameter	radius	frequency
2 mm	1 mm	7.3 l/mm
4 "	2 "	14.6 "
6 "	3 "	21.9 "
8 "	4 "	29.2 "
10 "	5 "	36.5 "

This frequency range should

cover the region of interest.

Subject

Instructor's Name

Transmission requirements for filters

$$T_I = 10^{-D} \quad D = \gamma \log E \quad E = I \cdot x \quad \text{let } x = 1$$

$$T_I = I^{-\gamma}$$

$$T_A = (I)^{-\gamma/2} = (|A|^2)^{-\gamma/2}$$

$$\text{if } \gamma = -1$$

$$T_A \approx |A|$$

Consider filter attenuation requirements —

$$\text{if } D = 0.3 \quad T_I \approx 50.12\% \quad T_A \approx 70.5\%$$

$$\text{if } D = 0.6 \quad T_I \approx 25.12\% \quad T_A \approx 50\%$$

$$D = 0.4 \quad " \quad 39.81\% \quad " \approx 63\%$$

$$" \quad 0.5 \quad " \quad 31.62\% \quad " \approx 56.2\%$$

$$" \quad 0.7 \quad " \quad 19.95\% \quad " \approx 43.5\%$$

This is the general category of transmission filters that we will use during the initial experiments for low contrast image manipulation.